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ABSTRACT

The purpose of the civil highway curriculum evaluation was to provide data for course review and revision. As civil engineering is a rapidly changing occupational field, it is important to determine what skills are currently essential for civil highway technicians. The associate degree programs in the four Wisconsin technical institutes offering the civil highway technician curriculum were summarized and presented to both program graduates (1970-1973) and to potential and actual employers for their assessment of the importance of the abilities required on the job. Responses from 62 graduates and 21 employers were tabulated for their impressions of the kind and degree of knowledge needed for each course element in the program. The principal conclusion from the data was that more emphasis is needed on communication skills, particularly written reports. Conflicting responses in the areas of mathematics and sciences indicate that further research is needed in these areas. As the employers surveyed were not necessarily those who hired the graduates, some differences of opinion may be due to differences in type of employment. The student and employer questionnaires (each eight pages long), a list of employers of the respondent graduates, and a list of employer respondents are appended. (Author/MF)

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FINAL REPORT

Project No. 13-001-151-124
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Civil Highway Curriculum Evaluation

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Northeast Wisconsin Vocational, Technical and Adult
Education District

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I. INTRODUCTION

SUMMARY

The purpose of the Civil Highway curriculum evaluation was to provide data for course review and revisio[illegible] [illegible]re [illegible] four associate degree Civil Highway programs in the Wisconsin Vocational, Technical and Adult Education system which may benefit from the results of this study. The tasks reviewed by program graduates as well as their potential employers represent a summary of the curriculum of all four programs. The responses consisted basically of their impressions on the importance of these tasks to the work performed by Civil Highway technicians.

BACKGROUND OF THE STUDY

This study was originally undertaken at the request of the Wisconsin Board of Vocational, Technical and Adult Education in cooperation with the technical institutes offering this program. They include Northeast Wisconsin Technical Institute, Madison Area Technical College, Mid-State Technical Institute, and Milwaukee Area Technical Institute. It was recognized by all concerned that the field of civil engineering is a rapidly changing occupational field because of various scientific and technological developments. Everyone concerned had recognized that skills in the field of civil engineering were changing at an ever increasing rate.

Changing technology in any field results in difficult situations. Students sometime graduate with obsolete skills and employers become disenchanted with the educational process.

The purpose of this research was to determine what skills and abilities are now essential to a civil highway technician. In reaching that goal, the basic objectives of all four programs in the Wisconsin VTAE System were summarized and presented to both employers and employees. They were then asked

to consider each objective relative to what is actually required on the job and rank the importance of the item accordingly.

It was felt that this research would serve to upgrade the Civil Highway curriculum in all four institutions. Understanding the needs of both the employer and the employees was considered to be a sound basis for modifying curriculum and it was hoped that this research would provide that type of data.

Two questions emerge from the problem and purpose considered in this study. These are: 1.) What skills and abilities are important in the performance of a civil highway technician's duties as perceived by the employer; and, 2.) What skills and abilities are important in the performance of a civil highway technician's duties as perceived by the employe (technical institute graduate)?

The U.S. Department of Labor describes a civil engineering technician as follows: "Technicians trained in this area assist civil engineers in performing many of the tasks necessary in the planning, design, and construction of highways, railroads, bridges, viaducts, dams and other types of structures. During the planning stage, technicians may help to estimate costs, to prepare specifications for materials, or participate in surveying, drafting, detailing, or designing work. Once the actual construction work has begun, they may assist the contractor or superintendent in scheduling construction activities or inspecting the work to assure conformance to blueprints and specifications.

The Department of Labor also recognizes that employment opportunities for these technicians will be very good through the 1970's. This demand will be strongest for technican graduates of post-secondary training programs.

The training programs in the Wisconsin VTAE system for civil highway technicians are post-secondary, associate degree offerings and are quite similar in nature. Typical courses in the first year include technical science, math, communication skills, surveying, estimating, psychology, drafting and construction-masonry. Second year courses include concrete, structural

analysis, soils and foundations, surveying, highway design, materials testing, and inspection. These are variations by institution in these offerings and their titles but all cover basically the same material over the course of the program.

METHODOLOGY

The methodology utilized to conduct this study was developed in four distinct phases. These include: 1. Curriculum review and instrument development; 2. Mailing and personal interviews; 3. Data analysis; and 4. Development of the conclusions and recommendations. It should be noted that phases 1. and 2. were conducted by the project assistants and that the data analysis and conclusions and recommendations were completed by the Administrator of Research and Planning at Northeast Wisconsin Technical Institute.

The first step involved collecting curriculum material from all four programs. Each institution submitted course outlines and curriculum materials to the project assistants. They were then analyzed and compiled to include all of the program variations.

The research assistants then developed a working knowledge of all four programs. Having identified the elements of all the programs, they prepared the list of tasks which formed the basic instrument of the study.

Part of this first step was the development and testing of the questionnaire for the graduates and the employers. The questionnaire developed contained the task listing and was tested locally on NWTI graduates and on project engineers in the Wisconsin Division of Highways who performed the role of employers. As a result of this procedure the questionnaires were modified somewhat to include items which the program graduates and the employers felt were important.

Mailing lists of the prominent employers of civil engineering technicians in the state of Wisconsin were obtained. In consulting with civil technology

instructors from around the state, a listing of 21 such employers was developed. A final step was to obtain mailing lists of recent graduates from all four programs. This was completed and a listing of 194 civil technology graduates was developed.

Following the development of the questionnaire and mailing lists, the instrument was mailed and interviews were conducted using the survey document as a guideline. In that process 192 forms were mailed to students. Twenty-two were returned with no forwarding addresses. A total number of 62 forms were returned for a rate of response of 36 percent. A total of 21 employers were involved in the study. Fifteen of the 21 responses came as a result of personal interviews by the research assistants at the the employers' place of business.

The data was then tabulated, analyzed and reviewed for the purpose of completing this report. It should be noted that the tabulations were simple descriptive statistics and that no effort was made to correlate the questionnaire responses. The conclusions and recommendations were developed after a review of this data.

II. FINDINGS AND ANALYSIS

STUDENT DATA

Total Number of Student Respondents: 62

Student Respondents by Year of Graduation:

1970 - 12
1971 - 15
1972 - 16
1973 - 18
Unknown - 1

Student Respondents by Job Status:

Full Time - 59
Part Time - 2
Military - 1

Student Respondents by Relationship of Employment to Training:

Directly Related - 47
Somewhat Related - 12
Not Related - 3

Initial Employment Obtained Before Graduation:

Yes - 43
No - 19

What assistance did you have in obtaining your initial job? (Who or What?)

Friend - 14
Parent - 2
School - 17
Teacher - 15
Department Head - 4
Wisconsin Employment Service - 2
Newspaper Ad - 2
Other - 6 - Inquiry by employer to school
Parents' Business
Self
Brother
Mother-in-law
Phone Book

Student Respondents Rating of the Degree of Knowledge Required
For Their Assignment as a Civil Highway Technician

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
General Education				
Communication Skills				
General English Concepts	27 (44%)	27 (44%)	6 (10%)	2 (3%)
Speech	30 (48%)	26 (42%)	3 (5%)	3 (5%)
Mass Media	16 (26%)	35 (56%)	10 (16%)	1 (2%)
Written Communication	36 (58%)	19 (31%)	3 (5%)	4 (6%)
Business Communication	29 (47%)	24 (39%)	4 (6%)	5 (8%)
Technical Report Writing	30 (48%)	20 (32%)	5 (8%)	7 (11%)
Recordkeeping	28 (45%)	23 (37%)	7 (11%)	4 (6%)
Reading & Understanding Tech Data	40 (65%)	15 (24%)	2 (3%)	5 (8%)
History and Government				
An understanding of man and his relationship to social and political situations in society.	16 (26%)	29 (47%)	14 (23%)	3 (5%)
Function and Operation of Local Governments	25 (40%)	25 (40%)	10 (16%)	3 (5%)
Comments				
Psychology and Human Relations				
An understanding of man and his relationship to other men in society.	24 (39%)	29 (47%)	7 (11%)	2 (3%)
Comments:				
Economics				
An understanding of man and his relationship to his social-economic environment.	16 (26%)	33 (53%)	10 (16%)	3 (5%)
Comments:				
Mathematics				
Basic Mathematics	57 (92%)	3 (5%)	0	2 (3%)
Algebra	48 (77%)	10 (16%)	1 (2%)	3 (5%)
Geometry	46 (74%)	9 (15%)	3 (5%)	4 (6%)
Trigonometry	45 (73%)	9 (15%)	5 (8%)	3 (5%)
Basic Calculus	22 (35%)	26 (42%)	12 (19%)	2 (3%)
Force Systems	20 (32%)	36 (58%)	6 (10%)	0
Concepts of Stress & Strain	26 (42%)	26 (42%)	8 (13%)	2 (3%)
Shears and Moments in Beams	24 (39%)	30 (48%)	8 (13%)	0
Deflection of Beams	16 (26%)	34 (55%)	10 (16%)	2 (3%)
Logarithms	22 (35%)	18 (29%)	18 (29%)	4 (6%)
Data Processing	14 (23%)	30 (48%)	18 (29%)	0
Electronic Calculators	40 (65)	16 (26%)	6 (10%)	0
Slide Rule	46 (74%)	14 (23%)	2 (3%)	0
Smoley's Tables	16 (26%)	22 (35%)	22 (35%)	2 (3%)
Comments:				

Science - Physics	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Properties of Matter	20 (32%)	30 (48%)	12 (19%)	0
Vectors	16 (42%)	28 (45%)	18 (29%)	0
Principles of Heat	14 (23%)	32 (52%)	14 (23%)	2 (3%)
Principles of Sound	10 (16%)	32 (52%)	20 (32%)	0
Principles of Light	13 (19%)	26 (42%)	24 (39%)	0
Principles of Electricity	20 (32%)	24 (39%)	18 (28%)	0
Comments:				
Surveying Subjects				
The Engineer's Transit:				
Measurement of horizontal angles	48 (77%)	8 (13%)	6 (10%)	0
Laying off horizontal angles	50 (81%)	6 (10%)	4 (6%)	2 (3%)
Alignment	50 (81%)	8 (13%)	2 (3%)	2 (3%)
Measurement of vertical angles	38 (61%)	14 (23%)	8 (13%)	2 (3%)
Checking and adjustment of a transit	40 (65%)	14 (23%)	6 (10%)	2 (3%)
The Theodolite:				
Measurement of vertical angles	34 (55%)	16 (26%)	10 (16%)	2 (3%)
Measurement of horizontal angles	42 (68%)	8 (13%)	8 (13%)	4 (6%)
Measurement of Distances:				
With a steel tape	50 (81%)	6 (10%)	2 (3%)	4 (6%)
With a calibrated tape	46 (74%)	10 (16%)	4 (6%)	2 (3%)
With an electronic distance meter	28 (45%)	22 (35%)	10 (16%)	2 (3%)
Measurement of Difference in Elevation:				
Instrument Man, Rod Man or Tapesman	54 (87%)	4 (6%)	4 (6%)	0
Checking and adjusting the level	46 (74%)	10 (16%)	4 (6%)	2 (3%)
Differential leveling	46 (74%)	10 (16%)	6 (20%)	0
Profile Leveling	48 (77%)	12 (19%)	2 (3%)	0
Cross-sectioning	40 (65%)	10 (16%)	8 (13%)	4 (6%)
Contour leveling	34 (55%)	16 (26%)	8 (13%)	4 (6%)
Setting slope or grade stakes	34 (55%)	12 (19%)	12 (19%)	4 (6%)
Field Notes:				
Notekeeping	48 (77%)	4 (6%)	6 (10%)	4 (6%)
Checking field notes	44 (71%)	8 (13%)	6 (10%)	4 (6%)
Adjustment of notes	38 (61%)	10 (16%)	10 (16%)	4 (6%)
Reducing notes	36 (58%)	12 (19%)	10 (16%)	4 (6%)
Computations:				
Adjustment of distances; temp.; sag; pull; etc..	24 (39%)	20 (32%)	16 (26%)	2 (3%)
Adjustment of angles; open or closed traverse	24 (39%)	20 (32%)	14 (23%)	4 (6%)
Compute bearings from angles	22 (35%)	20 (32%)	16 (26%)	4 (6%)
Compute angles from bearings	24 (39%)	20 (32%)	14 (23%)	4 (6%)
Determine true bearing from Polaris	12 (19%)	20 (32%)	26 (42%)	4 (6%)
Determine true bearing from sun	10 (16%)	20 (32%)	28 (45%)	4 (6%)

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Computations, cont.				
Compute and adjust latitudes and departures	20 (32%)	16 (26%)	20 (32%)	6 (10%)
Compute the accuracy of the survey	24 (39%)	22 (35%)	12 (19%)	4 (6%)
Computation of coordinates and state grid coordinates	18 (29%)	26 (42%)	16 (26%)	2 (3%)
Compute of omitted measurements	22 (35%)	20 (32%)	16 (26%)	4 (6%)
Calculation of areas of land	36 (58%)	10 (16%)	12 (19%)	4 (6%)
Route Surveys				
Transit-tape surveys	34 (55%)	12 (19%)	12 (19%)	4 (6%)
Circular curves	30 (48%)	16 (26%)	14 (23%)	2 (3%)
Spiral curves	12 (19%)	26 (42%)	20 (32%)	4 (6%)
Earthwork quantities	36 (58%)	12 (19%)	10 (16%)	4 (6%)
Land ties	34 (55%)	12 (19%)	12 (19%)	4 (6%)
Vertical curves	32 (52%)	14 (23%)	14 (23%)	2 (3%)
Construction roadbed staking	40 (65%)	8 (13%)	12 (19%)	2 (3%)
Construction structure staking	42 (68%)	8 (13%)	10 (16%)	2 (3%)
Stadia Surveying	26 (42%)	12 (19%)	14 (23%)	10 (16%)
Topographic Surveying and Mapping	22 (35%)	24 (39%)	12 (19%)	4 (6%)
Hydrographic Surveying and Flow Measurement	8 (13%)	34 (55%)	15 (26%)	4 (6%)
Photogrammetic Surveying	10 (16%)	26 (42%)	22 (35%)	4 (6%)
Land-Surveying	30 (48%)	20 (32%)	8 (13%)	4 (6%)
Land Survey				
Laws relating to public land surveying	32 (52%)	26 (42%)	2 (3%)	2 (3%)
Sectionalized land system	32 (52%)	22 (35%)	6 (10%)	2 (3%)
Systems used to describe property	40 (65%)	15 (26%)	2 (3%)	4 (6%)
Locating metes and bounds conveyances	26 (42%)	28 (45%)	6 (10%)	2 (3%)
Subdivision of lands	34 (55%)	20 (32%)	8 (13%)	0
Restoration of lost corners	34 (55%)	20 (32%)	6 (10%)	2 (3%)
Resurveys	36 (58%)	20 (32%)	4 (6%)	2 (3%)
Field Notes				
Notekeeping	48 (77%)	10 (16%)	2 (3%)	2 (3%)
Checking field notes	52 (84%)	6 (10%)	2 (3%)	2 (3%)
Adjusting	48 (77%)	12 (19%)	2 (3%)	0
Reduction	46 (74%)	10 (16%)	4 (6%)	2 (3%)
Comments:				

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary	No Response
Drafting				
Skills				
Line weight	48 (77%)	6 (10%)	4 (6%)	4 (6%)
Composition	46 (74%)	8 (13%)	4 (6%)	4 (6%)
Lettering: Pencil	44 (71%)	12 (19%)	4 (6%)	2 (3%)
Ink	38 (61%)	16 (26%)	4 (6%)	4 (6%)
Mechanical (LeRoy)	38 (61%)	12 (19%)	8 (13%)	4 (6%)
Comments:				

Drafting media used	Always Used	Some Used	Not Used	No Response
Pencil	40 (65%)	8 (13%)	4 (6%)	10 (16%)
Ink	22 (35%)	25 (42%)	4 (6%)	10 (16%)
Tracing Paper	30 (48%)	16 (26%)	5 (10%)	10 (16%)
Tracing Cloth	14 (23%)	20 (32%)	14 (23%)	14 (23%)
Plastic Film	10 (16%)	24 (39%)	14 (23%)	14 (23%)
Comment:				

Drafting Subjects	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary	No Response
Geometric Comstruction	22 (35%)	26 (42%)	12 (19%)	2 (3%)
Orthographic projection	14 (23%)	22 (35%)	26 (42%)	0
Isometric views	18 (29%)	22 (35%)	20 (32%)	2 (3%)
Oblique views	18 (29%)	22 (35%)	20 (32%)	2 (3%)
Auxiliary views	20 (32%)	22 (35%)	18 (29%)	2 (3%)
Developments	16 (26%)	26 (42%)	15 (26%)	4 (6%)
Charts & graphs	30 (48%)	26 (42%)	2 (3%)	4 (6%)
Dimensioning	42 (68%)	14 (23%)	2 (3%)	4 (6%)
Fasteners	18 (29%)	26 (42%)	18 (29%)	0
Lt. const., plans, elevations, details	36 (58%)	20 (32%)	2 (3%)	4 (6%)
Structural Steel details	24 (39%)	22 (35%)	12 (19%)	4 (6%)
Reinforced concrete details	38 (61%)	16 (26%)	4 (6%)	4 (6%)
Prestressed concrete details	30 (48%)	22 (35%)	6 (10%)	4 (6%)
Manhole and sewer details	36 (58%)	14 (23%)	6 (10%)	6 (10%)
Highway structures	36 (58%)	16 (26%)	6 (10%)	4 (6%)
Geographical maps (small scale)	28 (45%)	18 (29%)	10 (16%)	6 (10%)
Topographic maps (large scale)	34 (55%)	14 (23%)	8 (13%)	6 (10%)
Stadia drawings	18 (29%)	24 (39%)	14 (23%)	6 (10%)
Contours	32 (52%)	20 (32%)	4 (6%)	6 (10%)
Certified survey maps	34 (55%)	18 (29%)	8 (13%)	2 (3%)
Sub-division plats	32 (52%)	22 (35%)	2 (3%)	6 (10%)
Cross sections	42 (68%)	10 (16%)	4 (6%)	6 (10%)
Profiles	40 (65%)	10 (16%)	6 (10%)	6 (10%)
Right of way plats	34 (55%)	12 (19%)	8 (13%)	8 (13%)
Highway Topography	32 (52%)	8 (13%)	14 (23%)	8 (13%)
Highway Geometric design	24 (39%)	16 (26%)	14 (23%)	8 (13%)
Highway Plans	30 (48%)	14 (23%)	14 (23%)	4 (6%)
Highway details	32 (52%)	10 (16%)	10 (16%)	10 (16%)

Drafting Subjects (cont.)	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary	No Response
Rural intersections	26 (42%)	16 (26%)	16 (26%)	4 (6%)
Urban intersections	26 (42%)	12 (19%)	20 (32%)	4 (6%)
Highway drainage	30 (48%)	14 (23%)	14 (23%)	4 (6%)
Highway lighting	10 (16%)	24 (39%)	20 (32%)	8 (13%)
Traffic control devices	10 (16%)	22 (35%)	26 (42%)	4 (6%)
Comments:				
Material Testing				
Aggregate testing	42 (68%)	14 (23%)	6 (10%)	0
Portland cement concrete testing	38 (61%)	18 (29%)	6 (10%)	0
Asphalt concrete testing	26 (42%)	28 (45%)	8 (13%)	0
Comments:				
Soils				
Composition and structure of soil	40 (65%)	12 (19%)	2 (3%)	8 (13%)
Compaction testing	46 (74%)	12 (19%)	4 (6%)	0
Soil classification	42 (68%)	12 (19%)	6 (10%)	2 (3%)
Soil testing and analyses	44 (71%)	12 (19%)	6 (10%)	2 (3%)
Comments:				
Material Testing				
Classification and identification of common rocks	20 (32%)	34 (55%)	8 (13%)	0
Physical properties - strength, durability, porosity, workability, specific gravity	36 (58%)	14 (23%)	10 (16%)	2 (3%)
Production of crushed rock and stone	32 (52%)	24 (39%)	6 (10%)	0
Methods of sampling and testing	50 (81%)	8 (13%)	4 (6%)	0
Gradation and design	46 (74%)	12 (19%)	4 (6%)	0
Handling and storing aggregates	42 (68%)	14 (23%)	6 (10%)	0
Portland Cement Concrete				
Elements of quality concrete - workability, strengths, permability, and durability	48 (77%)	10 (16%)	4 (6%)	0
Concrete mixtures design and admixtures	46 (74%)	12 (19%)	4 (6%)	0
Manufacture and transportation of concrete	40 (65%)	12 (19%)	10 (16%)	0
Placement and handling	46 (74%)	12 (19%)	4 (6%)	0
Plant and field testing & inspection	50 (91%)	10 (16%)	2 (3%)	0
Asphalt Concrete				
Aggregate sampling and testing	36 (58%)	18 (29%)	6 (10%)	2 (3%)
Mix design principles	32 (52%)	22 (35%)	8 (13%)	0
Manufacture and transportation	28 (45%)	24 (39%)	10 (16%)	0
Placement methods and equipment	34 (55%)	22 (35%)	6 (10%)	0
Plant and field testing and inspection	38 (61%)	16 (26%)	8 (13%)	0

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Soil Mechanics				
Composition and structure of soil				
Soil type and classification	30 (48%)	24 (39%)	8 (13%)	0
Granular structure	30 (48%)	22 (35%)	8 (13%)	2 (3%)
Tests and Analyses				
Water Content (field and lab)	34 (55%)	14 (23%)	12 (19%)	2 (3%)
Grain size analyses	28 (45%)	16 (26%)	16 (26%)	2 (3%)
Specific gravity	26 (42%)	12 (19%)	22 (35%)	2 (3%)
Atterberg Limits	18 (29%)	18 (29%)	24 (39%)	2 (3%)
Soil identification	22 (35%)	24 (39%)	14 (23%)	2 (3%)
Moisture - Density				
Water balloon	8 (13%)	28 (45%)	26 (42%)	0
Sand cone	20 (32%)	24 (39%)	18 (29%)	0
Nuclear	20 (32%)	20 (32%)	22 (35%)	0
California Bearing Ratio	16 (26%)	18 (29%)	26 (42%)	2 (3%)
Consolidation	20 (32%)	22 (35%)	16 (26%)	4 (6%)
Soil Sampling				
Auger	18 (29%)	24 (39%)	20 (32%)	0
Shelby Tube	14 (23%)	28 (45%)	20 (32%)	0
Split Spoon	12 (19%)	28 (45%)	22 (35%)	0
Unconfined Compressive Strength	16 (26%)	22 (35%)	24 (39%)	0
Percolation	26 (42%)	28 (45%)	6 (10%)	2 (3%)
Seismograph Exploration	6 (10%)	28 (45%)	28 (45%)	0
Resistivity Exploration	6 (10%)	24 (39%)	30 (48%)	2 (3%)

EMPLOYER DATA

Total Number of Employer Respondents: 21

Average Number of employees: 59 (6 no response) Average number of technicians: 17 (1 no response)

Total Number of Civil Highway Technicians employed by the respondents as technicians: 87 (4 no response)

Certification of Technicians:

Required - 3
Desirable - 8
Not necessary - 5
No reponse - 5

Future need for certification of technicians:

Yes - 12
No - 4
No response - 5

General statements on tasks performed by technicians:

Drafting
Surveying
Basic water system design
New construction inspection of water distribution system
Construction survey
Easements
Construction inspection and drafting
Quality Control
Structural drafting
Rod man
Crew chief
Assistant to District engineer
Tech I-IV
Instrument men
Draftsmen
Computer operators

Employer Respondents Rating of the Degree of Knowledge Required
For Their Civil Highway Technicians

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
General Education				
Communication Skills				
General English Concepts	16 (75%)	2 (10%)	1 (5%)	2 (10%)
Speech	12 (57%)	4 (19%)	1 (5%)	4 (19%)
Mass Media	6 (28%)	10 (48%)	2 (10%)	3 (14%)
Written Communication	13 (62%)	6 (28%)	0	2 (10%)
Business Communication	11 (52%)	8 (38%)	0	2 (10%)
Technical Report Writing	10 (48%)	8 (38%)	1 (5%)	2 (10%)
Recordkeeping	15 (71%)	2 (10%)	1 (5%)	3 (14%)
Reading and Understanding Technical Data	14 (66%)	5 (24%)	0	2 (10%)
History and Government				
An understanding of man and his relationship to social and political situations in society.	5 (24%)	11 (52%)	1 (5%)	4 (19%)
Function and Operation of local gov't.	9 (43%)	8 (38%)	1 (5%)	3 (14%)
Psychology and Human Relations				
An understanding of man and his relationship to other men in society.	6 (28%)	8 (38%)	3 (14%)	4 (19%)
Comments:				
Economics				
An understanding of man and his relationship to his social-economic environment.	3 (14%)	12 (57%)	4 (19%)	2 (10%)
Comments:				
Mathematics				
Basic Mathematics	18 (86%)	0	0	3 (14%)
Algebra	15 (81%)	4 (19%)	0	2 (10%)
Geometry	16 (75%)	3 (14%)	0	2 (10%)
Trigonometry	15 (71%)	3 (14%)	0	3 (14%)
Force Systems	5 (24%)	8 (38%)	4 (19%)	4 (19%)
Concepts of Stress & Strain	4 (19%)	10 (48%)	5 (24%)	2 (10%)
Sheers and Moments in Beams	4 (19%)	10 (48%)	4 (19%)	3 (14%)
Deflection of Beams	4 (19%)	9 (43%)	6 (28%)	2 (10%)
Logarithms	6 (28%)	5 (24%)	8 (38%)	2 (10%)
Data Processing	1 (5%)	12 (57%)	5 (24%)	3 (14%)
Electronic Calculators	13 (62%)	6 (28%)	0	2 (10%)
Slide Rule	6 (28%)	8 (38%)	5 (24%)	2 (10%)
Smoley's Tables	2 (10%)	8 (38%)	9 (43%)	2 (10%)
Comments:				
Science - Physics				
Properties of Matter	2 (10%)	10 (48%)	6 (28%)	3 (14%)
Vectors	0	9 (43%)	9 (43%)	3 (14%)
Principles of Heat	1 (5%)	6 (28%)	11 (52%)	3 (14%)

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Science - Physics (con't.)				
Principles of Sound	1 (5%)	7 (33%)	10 (48%)	3 (14%)
Principles of Light	0	7 (33%)	11 (52%)	3 (14%)
Principles of Electricity	0	10 (48%)	8 (38%)	3 (14%)
Comments:				
Surveying Subjects				
The Engineer's Transit. (Type of instrument 1 min.___; 30 sec.___; 20 sec.___.)				
Measurement of horinzontal angles	17 (80%)	3 (14%)	0	1 (5%)
Laying off horizontal angles	17 (80%)	2 (10%)	0	2 (10%)
Alignment	17 (80%)	2 (10%)	0	2 (10%)
Measurement of vertical angles	17 (80%)	2 (10%)	0	2 (10%)
Checking and adjustment of a transit	15 (71%)	3 (14%)	0	3 (14%)
The Theodolite (Type of instrument 20 sec.___; one sec.___.)				
Measurement of vertical angles	8 (38%)	4 (19%)	1 (5%)	8 (38%)
Measurement of horizontal angles	8 (38%)	5 (24%)	2 (10%)	6 (28%)
Measurement of Distances				
with a steel tape	18 (86%)	1 (5%)	0	2 (10%)
with a calibrated tape	9 (43%)	3 (14%)	7 (33%)	2 (10%)
with an electronic distance meter	7 (33%)	8 (38%)	3 (14%)	3 (14%)
Measurement of Differences in Elevation				
Instrument Man, Rod Man or Tapesman	17 (80%)	1 (5%)	0	3 (14%)
Checking and adjusting the level	17 (80%)	2 (10%)	0	3 (14%)
Differential Leveling	16 (75%)	2 (10%)	0	3 (14%)
Profile Leveling	16 (75%)	2 (10%)	0	3 (14%)
Cross-sectioning	16 (75%)	2 (10%)	0	3 (14%)
Contour leveling	15 (71%)	1 (5%)	3 (14%)	2 (10%)
Setting slope or grade stakes	17 (80%)	1 (5%)	1 (5%)	2 (10%)
Field Notes				
Note keeping	15 (71%)	2 (10%)	1 (5%)	3 (14%)
Checking field notes	15 (71%)	2 (10%)	1 (5%)	3 (14%)
Adjustment of notes	15 (71%)	2 (10%)	1 (5%)	3 (14%)
Reducing notes	14 (66%)	3 (14%)	1 (5%)	3 (14%)
Computations				
Adjustment of distances; temp., sag, pull, etc.	8 (38%)	5 (24%)	5 (24%)	3 (14%)
Adjustment of angles; open or closed traverse	11 (52%)	6 (28%)	2 (10%)	2 (10%)
Compute bearings from angles				
Compute angles from bearings	12 (57%)	5 (24%)	1 (5%)	3 (14%)
Determine a true bearing from Polaris	5 (24%)	10 (48%)	4 (19%)	2 (10%)
Determine a true bearing from the sun	5 (24%)	7 (33%)	6 (28%)	3 (14%)

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Compute and adjust latitudes and departures	12 (57%)	5 (24%)	3 (14%)	1 (5%)
Compute the accuracy of the survey	13 (62%)	5 (24%)	2 (10%)	1 (5%)
Computation of coordinates and state grid coordinates	12 (57%)	7 (33%)	2 (10%)	0
Compute of omitted measurements	16 (75%)	4 (19%)	1 (5%)	0
Calculation of areas of land	15 (71%)	4 (19%)	2 (10%)	0
Route Surveys				
Transit-tape surveys	17 (80%)	2 (10%)	1 (5%)	1 (5%)
Circular curves	16 (75%)	1 (5%)	2 (10%)	2 (10%)
Spiral curves	7 (35%)	5 (24%)	7 (33%)	2 (10%)
Earthwork quantities	13 (62%)	4 (19%)	2 (10%)	2 (10%)
Land ties	14 (66%)	3 (14%)	1 (5%)	3 (14%)
Vertical curves	15 (71%)	2 (10%)	2 (10%)	2 (10%)
Construction Roadbed staking	14 (66%)	3 (14%)	2 (10%)	2 (10%)
Construction structure staking	13 (62%)	5 (24%)	1 (5%)	2 (10%)
Stadia Surveying	9 (43%)	10 (48%)	2 (10%)	0
Topographic Surveying and Mapping	13 (62%)	5 (24%)	1 (5%)	2 (10%)
Hydrographic Surveying and Flow Msrmt.	3 (14%)	10 (48%)	8 (38%)	0
Photogrammatic Surveying	3 (14%)	13 (62%)	4 (19%)	1 (5%)
Land surveying	5 (24%)	5 (24%)	1 (5%)	10 (48%)
Land Survey				
Laws relating to public land surveying	9 (43%)	10 (48%)	1 (5%)	1 (5%)
Sectionalized land system	10 (48%)	9 (43%)	1 (5%)	1 (5%)
Systems used to describe property	11 (52%)	8 (38%)	1 (5%)	1 (5%)
Locating metes and bounds conveyances	11 (52%)	7 (33%)	2 (10%)	1 (5%)
Subdivision of lands	10 (48%)	9 (43%)	1 (5%)	1 (5%)
Restoration of lost corners	10 (48%)	8 (38%)	1 (5%)	2 (10%)
Resurveys	11 (52%)	8 (33%)	2 (10%)	1 (5%)
Field Notes				
Note keeping	10 (48%)	1 (5%)	1 (5%)	9 (43%)
Checking field notes	10 (48%)	1 (5%)	1 (5%)	9 (43%)
Adjusting	10 (48%)	1 (5%)	1 (5%)	9 (43%)
Reduction	10 (48%)	1 (5%)	1 (5%)	9 (43%)
Comments:				

	Skill is Essential	Some Skill Necessary	No Skill Necessary	No Response
Drafting				
Skills				
Line weight	14 (66%)	3 (14%)	2 (10%)	2 (10%)
Composition	14 (66%)	3 (14%)	1 (5%)	3 (14%)
Lettering				
Pencil	10 (48%)	3 (14%)	1 (5%)	7 (33%)
Ink	13 (62%)	2 (10%)	2 (10%)	4 (19%)
Mechanical (LeRoy)	13 (62%)	2 (10%)	2 (10%)	4 (19%)
Comments:				

	Always Used	Some Used	Not Used	No Response
Drafting Media Used				
Pencil	12 (57%)	4 (19%)	0	5 (24%)
Ink	13 (62%)	3 (14%)	0	5 (24%)
Tracing Paper	10 (48%)	6 (28%)	1 (5%)	4 (19%)
Tracing Cloth	10 (48%)	4 (19%)	4 (19%)	3 (14%)
Plastic Film	9 (43%)	8 (38%)	0	4 (19%)
Comments:				

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Drafting Subjects				
Geometric Construction	13 (62%)	6 (28%)	0	2 (10%)
Orthographic projection	7 (33%)	10 (48%)	2 (10%)	2 (10%)
Isometric Views	6 (28%)	10 (48%)	2 (10%)	3 (14%)
Oblique views	4 (19%)	9 (43%)	5 (24%)	3 (14%)
Auxiliary views	6 (28%)	11 (52%)	1 (5%)	3 (14%)
Developments	2 (10%)	9 (43%)	7 (33%)	3 (14%)
Charts & graphs	9 (43%)	9 (43%)	2 (10%)	1 (5%)
Dimensioning	15 (71%)	4 (19%)	0	2 (10%)
Fasteners	4 (19%)	6 (28%)	7 (33%)	4 (19%)
Light construction; plans, elevations, and details	7 (33%)	8 (38%)	5 (24%)	1 (5%)
Structural steel details	7 (33%)	8 (38%)	5 (24%)	2 (10%)
Reinforced concrete details	8 (38%)	6 (28%)	5 (24%)	2 (10%)
Prestressed concrete details	7 (33%)	6 (28%)	5 (28%)	2 (10%)
Manhole and sewer details	9 (43%)	8 (38%)	1 (5%)	3 (14%)
Highway structures	9 (43%)	9 (43%)	2 (10%)	1 (5%)
Geographical maps (small scale)	9 (43%)	7 (33%)	2 (10%)	3 (14%)
Topographic maps (large scale)	11 (52%)	5 (24%)	1 (5%)	4 (19%)
Stadia drawings	9 (43%)	6 (28%)	3 (14%)	3 (14%)
Contours	11 (52%)	6 (28%)	2 (10%)	2 (10%)
Certified survey maps	8 (38%)	9 (43%)	1 (5%)	3 (14%)

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Sub-division plats	9 (43%)	5 (28%)	3 (14%)	3 (14%)
Cross sections	13 (62%)	4 (19%)	1 (5%)	3 (14%)
Profiles	13 (62%)	4 (19%)	1 (5%)	3 (14%)
Right-of-way plats	13 (62%)	3 (14%)	2 (10%)	3 (14%)
Highway topography	13 (62%)	4 (19%)	2 (10%)	2 (10%)
Highway geometric design	9 (43%)	7 (33%)	3 (14%)	2 (10%)
Highway plane	13 (62%)	4 (19%)	2 (10%)	2 (10%)
Highway details	12 (57%)	5 (28%)	1 (5%)	2 (10%)
Rural intersections	10 (48%)	7 (33%)	2 (10%)	2 (10%)
Urban intersections	10 (48%)	7 (33%)	2 (10%)	2 (10%)
Highway drainage	10 (48%)	5 (28%)	2 (10%)	3 (14%)
Highway lighting	5 (24%)	9 (43%)	6 (28%)	1 (5%)
Traffic control devices	5 (24%)	8 (38%)	6 (28%)	2 (10%)
Comments:				
Material Testing				
Aggregate testing	5 (24%)	7 (33%)	4 (19%)	5 (24%)
Portland Cement Concrete testing	4 (19%)	8 (38%)	4 (19%)	5 (24%)
Asphalt concrete testing	3 (14%)	8 (38%)	5 (24%)	5 (24%)
Comments:				
Soils				
Composition and structure of soil	3 (14%)	8 (38%)	3 (14%)	7 (33%)
Compaction testing	2 (10%)	9 (43%)	3 (14%)	7 (33%)
Soil classification	3 (14%)	8 (38%)	3 (14%)	7 (33%)
Soil testing and analyses	2 (10%)	8 (38%)	4 (19%)	7 (33%)
Comments:				
Material Testing				
Classification and identification of common rocks	2 (10%)	5 (24%)	2 (10%)	12 (57%)
Physical properties--strength, workability, specific gravity	2 (10%)	7 (33%)	0	12 (57%)
Production of crushed rocks & stone	2 (10%)	5 (24%)	1 (5%)	13 (62%)
Methods of sampling and testing	3 (14%)	5 (24%)	1 (5%)	12 (57%)
Gradation and Design	3 (14%)	5 (24%)	1 (5%)	12 (57%)
Handling and storing aggregates	3 (14%)	6 (28%)	0	12 (57%)
Portland Cement Concrete				
Elements of quality concrete--workability, strengths, permability, and durability	2 (20%)	6 (28%)	0	13 (62%)
Concrete mixtures design and admixture	2 (10%)	6 (28%)	0	13 (62%)
Manufacture and Transportation of concrete	3 (14%)	5 (24%)	1 (5%)	12 (57%)
Placement and Handling	4 (19%)	6 (28%)	0	11 (52%)
Plant and Field Testing and Inspection	4 (19%)	5 (24%)	0	12 (57%)

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary	No Response
Asphalt Concrete				
Aggregate Sampling and Testing	5 (24%)	3 (14%)	1 (5%)	12 (57%)
Mix design principles	3 (14%)	5 (24%)	1 (5%)	12 (57%)
Manufacture and transportation	6 (28%)	3 (14%)	1 (5%)	12 (57%)
Placement methods and equipment	5 (24%)	3 (14%)	1 (5%)	12 (57%)
Plantan Field Testing and Inspection	5 (24%)	3 (14%)	1 (5%)	12 (57%)
Soil Mechanics				
Composition and structure of soil				
Soil type and classification	2 (10%)	5 (24%)	1 (5%)	13 (62%)
Granular structure	1 (5%)	6 (28%)	1 (5%)	13 (52%)
Tests and Analyses				
Water content (field and lab)	1 (5%)	6 (28%)	2 (10%)	12 (57%)
Grain size analyses	1 (5%)	6 (28%)	2 (10%)	12 (57%)
Specific gravity	0	6 (28%)	3 (14%)	12 (57%)
Atterberg limits	0	6 (28%)	3 (14%)	12 (57%)
Soil identification	1 (5%)	5 (24%)	2 (10%)	13 (62%)
Moisture--Density				
A water balloon	2 (10%)	4 (19%)	2 (10%)	13 (62%)
B sand cone	1 (5%)	5 (24%)	2 (10%)	13 (62%)
C nuclear	0	5 (24%)	2 (10%)	14 (66%)
California bearing ratio	0	6 (28%)	3 (14%)	12 (57%)
Consolidation	0	6 (28%)	2 (10%)	13 (62%)
Soil sampling				
A auger	2 (10%)	5 (24%)	2 (10%)	12 (57%)
B shelby tube	1 (5%)	5 (24%)	2 (10%)	13 (62%)
C split spoon	1 (5%)	5 (24%)	2 (10%)	13 (62%)
Unconfined compressive strength	1 (5%)	5 (24%)	3 (14%)	12 (57%)
Percolation	3 (14%)	4 (19%)	3 (14%)	15 (52%)
Seismograph exploration	0	6 (28%)	4 (19%)	11 (52%)
Resistivity exploration	0	6 (28%)	4 (19%)	11 (52%)

III. CONCLUSIONS AND RECOMMENDATIONS

This section offers the opportunity to interpret the data presented in the preceeding chapter. Opinions on the meaning of the responses may differ and each user of the data is entitled to determine whether or not curriculum change is warranted. These conclusions are strictly the interpretations of the writer of the document and should be taken in that regard.

A limitation of the research should also be noted. The employers were not necessarily the firms who hired the graduates responding. Hence, differences of opinion on material testing or other job-related tasks may be due to differences in the kind of employment being discussed.

The first observation is that the employer places far more emphasis on communications than does the graduate. This was particularly true in the area of written reports. One could speculate that the employer recognizes problems undetected by the graduates. Based upon today's standards of writing, the employer probably has a legitimate priority. Few people learn to write in the contemporary educational system.

Recommendations on this issue are somewhat controversial. Perhaps the first step is to incorporate communications skills into the technical portion of the curriculum. The present courses entitled "communications skills" are too often thought of as excess baggage by both the technical student and his program instructor.

Additionally, it is not uncommon to find a technical subject instructor with a low level of communicative skill, particularly in writing.

There needs to be closer coordination between the communications instructor and the technical instructor. Joint assignments should be considered and the technical teacher needs to emphasize communicative skills in his/her approach to the occupational skills. This study clearly indicates

that the foster child image of the communications courses in technical programs needs to be discarded for equal status in the educational family.

The study data on mathematics is less definitive. Graduates placed greater emphasis on higher levels (calculus) than did employers. One might argue that the graduates have overstated their present capability in mathematics and that the employers feel they fall short in basic mathematics problem solving areas. That is a speculation but it is noteworthy that the employers placed emphasis on basic mathematical skills.

The situation in the science area appears reverse. Graduates saw a greater need for basic science than did employers. That appears to be inconsistant in that the employers emphasized math at the basic level and communication skills. Perhaps the employer thinks of science as higher mathematics in that he considers them both to have a lower priority in the skills and abilities required of a technician. One could speculate that he would rank them higher for professional engineers. In any event, a discrepancy exists in these areas and further job analysis would be required to determine the emphasis in science and math.

In general, the graduate and the employer share similar opinions on the technical subjects. They agree on the surveying topics and both note a return to ink in the drawing area. The graduates placed more emphasis on materials testing than did employers but that may be due to the mix of respondents in terms of the type of company or work performed.

In summary, this study concluded that more emphasis needs to be focused on communications skills and that further research needs to be directed toward the math and science areas. The technical or skill areas appear to be viewed similarly by employer and graduate and these views, where appropriate, can be used to place more or less emphasis on objectives included in the curriculum.

APPENDIX A

STUDENT QUESTIONNAIRE

CIVIL HIGHWAY SURVEY

PERSONAL DATA

Name: _____ Date of Graduation _____
Last First Middle Initial

Address: _____
(Where we can reach you) Street City State

EMPLOYMENT DATA

What is your present employment status?

Full Time_____ Part Time _____ Military Service _____ Unemployed____

If you checked Full-time, Part-time, or Military Service, How well does your Civil Highway training relate to your present job?

Directly related _____ Somewhat related _____ Not related _____

What jobs have you held since graduation?
(List all jobs after graduation to present)

Where employed	Job title	Length of job (Dates)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Was your initial employment obtained before your graduation date? Yes ____ No ____

What assistance did you have in obtaining your initial job? (who or what)

Friend _____ Parent _____ School guidance and placement _____

Teacher _____ Dept. head _____ Wisconsin Employment Service _____

Newspaper Ad _____ Other _____

Please rate the degree of knowledge you as a Civil Highway Technician feel is essential to the work you perform.

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
General Education			
Communication Skills			
General English Concepts	( )	( )	( )
Speech	( )	( )	( )
Mass Media	( )	( )	( )
Written Communication	( )	( )	( )
Business Communication	( )	( )	( )
Technical Report Writing	( )	( )	( )
Recordkeeping	( )	( )	( )
Reading and Understanding Technical Data	( )	( )	( )
History and Government			
An understanding of man and his relationship to social and political situations in society.	( )	( )	( )
Function and Operation of Local Governments	( )	( )	( )
Comments:			
Psychology and Human Relations			
An understanding of man and his relationship to other men in society.	( )	( )	( )
Comments:			
Economics			
An understanding of man and his relationship to his social-economic environment.	( )	( )	( )
Comments:			
Mathematics			
Basic Mathematics	( )	( )	( )
Algebra	( )	( )	( )
Geometry	( )	( )	( )
Trigonometry	( )	( )	( )
Basic Calculus	( )	( )	( )

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Force Systems	( )	( )	( )
Concepts of Stress & Strain	( )	( )	( )
Shears and Moments in Beams	( )	( )	( )
Deflection of Beams	( )	( )	( )
Logarithms	( )	( )	( )
Data Processing	( )	( )	( )
Electronic Calculators	( )	( )	( )
Slide Rule	( )	( )	( )
Smoley's Tables	( )	( )	( )
Comments:			

Science - Physics

Properties of Matter	( )	( )	( )
Vectors	( )	( )	( )
Principles of Heat	( )	( )	( )
Principles of Sound	( )	( )	( )
Principles of Light	( )	( )	( )
Principles of Electricity	( )	( )	( )
Comments:			

Surveying Subjects

The Engineer's Transit. (Type of instrument- 1 min. ___; 30 sec. ___; 20 sec. ___)			
Measurement of horizontal angles	( )	( )	( )
Laying off horizontal angles	( )	( )	( )
Alignment	( )	( )	( )
Measurement of vertical angles	( )	( )	( )
Checking and adjustment of a transit	( )	( )	( )
The Theodolite. (Type of instrument- 20 sec. ___; one sec. ___)			
Measurement of vertical angles	( )	( )	( )
Measurement of horizontal angles	( )	( )	( )
Measurement of Distances			
with a steel tape	( )	( )	( )
with a calibrated tape	( )	( )	( )
with an electronic distance meter	( )	( )	( )
Measurement of Difference in Elevation			
Instrument Man, Rod Man or Tapesman	( )	( )	( )
Checking and adjusting the level	( )	( )	( )
Differential Leveling	( )	( )	( )
Profile Leveling	( )	( )	( )

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Cross-sectioning	( )	( )	( )
Contour leveling	( )	( )	( )
Setting slope or grade stakes	( )	( )	( )
Field Notes			
Note Keeping	( )	( )	( )
Checking Field notes	( )	( )	( )
Adjustment of notes	( )	( )	( )
Reducing notes	( )	( )	( )
Computations			
Adjustment of distances; temp.; sag; pull; etc.	( )	( )	( )
Adjustment of angles; open or closed traverse	( )	( )	( )
Compute bearings from angles	( )	( )	( )
Compute angles from bearings	( )	( )	( )
Determine a true bearing from Polaris	( )	( )	( )
Determine a true bearing from the sun	( )	( )	( )
Compute and adjust latitudes and departures	( )	( )	( )
Compute the accuracy of the survey	( )	( )	( )
Computation of coordinates and state grid coordinates	( )	( )	( )
Compute of omitted measurements	( )	( )	( )
Calculation of areas of land	( )	( )	( )
Route Surveys			
Transit-tape surveys	( )	( )	( )
Circular curves	( )	( )	( )
Spiral curves	( )	( )	( )
Earthwork quantities	( )	( )	( )
Land ties	( )	( )	( )
Vertical curves	( )	( )	( )
Construction Roadbed staking	( )	( )	( )
Construction structure staking	( )	( )	( )
Stadia Surveying	( )	( )	( )
Topographic Surveying and Maping	( )	( )	( )
Hydrographic Surveying and Flow Measurement	( )	( )	( )
Photogrammetic Surveying	( )	( )	( )
Land Surveying	( )	( )	( )

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary
Land Survey			
Laws relating to public land surveying	( )	( )	( )
Sectionalized land system	( )	( )	( )
Systems used to describe property	( )	( )	( )
Locating metes and bounds conveyances	( )	( )	( )
Subdivision of lands	( )	( )	( )
Restoration of lost corners	( )	( )	( )
Resurveys	( )	( )	( )
Field Notes			
Note keeping	( )	( )	( )
Checking field notes	( )	( )	( )
Adjusting	( )	( )	( )
Reduction	( )	( )	( )
Comments:			
Drafting			
Skills			
Line weight	( )	( )	( )
Composition	( )	( )	( )
Lettering			
Pencil	( )	( )	( )
Ink	( )	( )	( )
Mechanical (LeRoy)	( )	( )	( )
Comments:			

Drafting Media Used	Always Used	Some Use	Not Used
Pencil	( )	( )	( )
Ink	( )	( )	( )
Tracing Paper	( )	( )	( )
Tracing Cloth	( )	( )	( )
Plastic film	( )	( )	( )
Comment:			

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary
Drafting Subjects			
Geometric Construction	( )	( )	( )
Orthographic projection	( )	( )	( )
Isometric views	( )	( )	( )
Obligue views	( )	( )	( )
Auxiliary views	( )	( )	( )
Developments	( )	( )	( )
Charts & graphs	( )	( )	( )
Dimensioning	( )	( )	( )
Fasteners	( )	( )	( )
Light construction; plans, elevations and details	( )	( )	( )
Structural Steel details	( )	( )	( )
Reinforced concrete details	( )	( )	( )
Prestressed concrete details	( )	( )	( )
Manhole and sewer details	( )	( )	( )
Highway structures	( )	( )	( )
Geographical maps (small scale)	( )	( )	( )
Topographic maps (large scale)	( )	( )	( )
Stadia drawings	( )	( )	( )
Contours	( )	( )	( )
Certified survey maps	( )	( )	( )
Sub-division plats	( )	( )	( )
Cross sections	( )	( )	( )
Profiles	( )	( )	( )
Right-of-way plats	( )	( )	( )
Highway Topography	( )	( )	( )
Highway Geometric design	( )	( )	( )
Highway Plans	( )	( )	( )
Highway details	( )	( )	( )
Rural intersections	( )	( )	( )
Urban intersections	( )	( )	( )
Highway drainage	( )	( )	( )
Highway lighting	( )	( )	( )
Traffic control devices	( )	( )	( )
Comments:			

Material Testing			
Aggregate testing	( )	( )	( )
Portland Cement Concrete testing	( )	( )	( )
Asphalt concrete testing	( )	( )	( )
Comments:			

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Soils			
Composition and structure of soil	( )	( )	( )
Compaction testing	( )	( )	( )
Soil classification	( )	( )	( )
Soil testing and analyses	( )	( )	( )
Comments:			
Material Testing			
Classification and Identification of Common rocks	( )	( )	( )
Physical properties - strength, durability, porosity, workability, specifc gravity	( )	( )	( )
Production of crushed rock and stone	( )	( )	( )
Methods of sampling and testing	( )	( )	( )
Gradation and design	( )	( )	( )
Handling and storing aggregates	( )	( )	( )
Portland Cement Concrete			
Elements of quality concrete - workability strengths, permability and durability	( )	( )	( )
Concrete mixtures design and admixtures	( )	( )	( )
Manufacture and transportation of concrete	( )	( )	( )
Placement and handling	( )	( )	( )
Plant and field testing and inspection	( )	( )	( )
Asphalt Concrete			
Aggregate sampling and testing	( )	( )	( )
Mix design principles	( )	( )	( )
Manufacture and transportation	( )	( )	( )
Placement methods and equipment	( )	( )	( )
Plant and field testing and inspection	( )	( )	( )
Soil Mechanics			
Composition and structure of soil			
Soil type and classification	( )	( )	( )
Granular structure	( )	( )	( )

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary
Tests and Analyses			
Water Content (field and lab)	( )	( )	( )
Grain size analyses	( )	( )	( )
Specific Gravity	( )	( )	( )
Atterberg Limits	( )	( )	( )
Soil Identification	( )	( )	( )
Moisture - Density			
Water balloon	( )	( )	( )
Sand cone	( )	( )	( )
Nuclear	( )	( )	( )
California Bearing Ratio	( )	( )	( )
Consolidation	( )	( )	( )
Soil Sampling			
Auger	( )	( )	( )
Shelby Tube	( )	( )	( )
Split Spoon	( )	( )	( )
Unconfined Compressive Strength	( )	( )	( )
Percolation	( )	( )	( )
Seismograph Exploration	( )	( )	( )
Resistivity Exploration	( )	( )	( )

APPENDIX B

EMPLOYER QUESTIONNAIRE

CIVIL HIGHWAY TECHNOLOGY SURVEY

Personal Interview

EMPLOYER DATA

Employer

Address

Name of person or persons completing this form

1. _____

2. _____

3. _____

What type of work is your firm involved in?

Number of employees _____ Number of Technicians _____

Number of C.H.T. graduates employed as technicians _____

Certification of Technicians: ___ Required, ___ Desireable, ___ Not Necessary
Do you foresee a need for certification of technicians in the future? ___ Yes ___No
Does your organization have a structured training program? ___ Yes ___ No
If Yes, explain briefly.

What jobs do your technicians perform?

What training do you expect a beginning technician to have when graduated from a Civil Highway program?

SUBJECT MATTER EVALUATION

Please rate the degree of knowledge that you as a Civil Highway technician employer feel is essential to do the type of work presently assigned these employees.

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
General Education			
Communication Skills			
General English Concepts	( )	( )	( )
Speech	( )	( )	( )
Mass Media	( )	( )	( )
Written Communication	( )	( )	( )
Business Communication	( )	( )	( )
Technical Report Writing	( )	( )	( )
Recordkeeping	( )	( )	( )
Reading and Understanding Technical Data	( )	( )	( )
History and Government			
An understanding of man and his relationship to social and political situations in society.	( )	( )	( )
Function and Operation of Local Governments	( )	( )	( )
Comments:			
Psychology and Human Relations			
An understanding of man and his relationship to other men in society.	( )	( )	( )
Comments:			
Economics			
An understanding of man and his relationship to his social-economic environment.	( )	( )	( )
Comments:			
Mathematics			
Basic Mathematics	( )	( )	( )
Algebra	( )	( )	( )
Geometry	( )	( )	( )
Trigonometry	( )	( )	( )
Basic Calculus	( )	( )	( )

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Force Systems	( )	( )	( )
Concepts of Stress & Strain	( )	( )	( )
Shears and Moments in Beams	( )	( )	( )
Deflection of Beams	( )	( )	( )
Logarithms	( )	( )	( )
Data Processing	( )	( )	( )
Electronic Calculators	( )	( )	( )
Slide Rule	( )	( )	( )
Smoley's Tables	( )	( )	( )
Comments:			

Science - Physics

Properties of Matter	( )	( )	( )
Vectors	( )	( )	( )
Principles of Heat	( )	( )	( )
Principles of Sound	( )	( )	( )
Principles of Light	( )	( )	( )
Principles of Electricity	( )	( )	( )
Comments:			

Surveying Subjects

The Engineer's Transit. (Type of instrument- 1 min. ___; 30 sec. ___; 20 sec. ___)			
Measurement of horizontal angles	( )	( )	( )
Laying off horizontal angles	( )	( )	( )
Alignment	( )	( )	( )
Measurement of vertical angles	( )	( )	( )
Checking and adjustment of a transit	( )	( )	( )
The Theodolite. (Type of instrument- 20 sec. ___; one sec. ___)			
Measurement of vertical angles	( )	( )	( )
Measurement of horizontal angles	( )	( )	( )
Measurement of Distances			
with a steel tape	( )	( )	( )
with a calibrated tape	( )	( )	( )
with an electronic distance meter	( )	( )	( )
Measurement of Difference in Elevation			
Instrument Man, Rod Man or Tapesman	( )	( )	( )
Checking and adjusting the level	( )	( )	( )
Differential Leveling	( )	( )	( )
Profile Leveling	( )	( )	( )

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Cross-sectioning	( )	( )	( )
Contour leveling	( )	( )	( )
Setting slope or grade stakes	( )	( )	( )
Field Notes			
Note Keeping	( )	( )	( )
Checking Field notes	( )	( )	( )
Adjustment of notes	( )	( )	( )
Reducing notes	( )	( )	( )
Computations			
Adjustment of distances; temp.; sag; pull; etc.	( )	( )	( )
Adjustment of angles; open or closed traverse	( )	( )	( )
Compute bearings from angles	( )	( )	( )
Compute angles from bearings	( )	( )	( )
Determine a true bearing from Polaris	( )	( )	( )
Determine a true bearing from the sun	( )	( )	( )
Compute and adjust latitudes and departures	( )	( )	( )
Compute the accuracy of the survey	( )	( )	( )
Computation of coordinates and state grid coordinates	( )	( )	( )
Compute of omitted measurements	( )	( )	( )
Calculation of areas of land	( )	( )	( )
Route Surveys			
Transit-tape surveys	( )	( )	( )
Circular curves	( )	( )	( )
Spiral curves	( )	( )	( )
Earthwork quantities	( )	( )	( )
Land ties	( )	( )	( )
Vertical curves	( )	( )	( )
Construction Roadbed staking	( )	( )	( )
Construction structure staking	( )	( )	( )
Stadia Surveying	( )	( )	( )
Topographic Surveying and Maping	( )	( )	( )
Hydrographic Surveying and Flow Measurement	( )	( )	( )
Photogrammetic Surveying	( )	( )	( )
Land Surveying	( )	( )	( )

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary
Land Survey			
Laws relating to public land surveying	( )	( )	( )
Sectionalized land system	( )	( )	( )
Systems used to describe property	( )	( )	( )
Locating metes and bounds conveyances	( )	( )	( )
Subdivision of lands	( )	( )	( )
Restoration of lost corners	( )	( )	( )
Resurveys	( )	( )	( )
Field Notes			
Note keeping	( )	( )	( )
Checking field notes	( )	( )	( )
Adjusting	( )	( )	( )
Reduction	( )	( )	( )
Comments:			
Drafting			
Skills			
Line weight	( )	( )	( )
Composition	( )	( )	( )
Lettering			
Pencil	( )	( )	( )
Ink	( )	( )	( )
Mechanical (LeRoy)	( )	( )	( )
Comments:			

Drafting Media Used	Always Used	Some Use	Not Used
Pencil	( )	( )	( )
Ink	( )	( )	( )
Tracing Paper	( )	( )	( )
Tracing Cloth	( )	( )	( )
Plastic film	( )	( )	( )
Comment:			

	Knowledge is Necessary	Some Knowledge Necessary	No Knowledge Necessary
Drafting Subjects			
Geometric Construction	( )	( )	( )
Orthographic projection	( )	( )	( )
Isometric views	( )	( )	( )
Obligue views	( )	( )	( )
Auxiliary views	( )	( )	( )
Developments	( )	( )	( )
Charts & graphs	( )	( )	( )
Dimensioning	( )	( )	( )
Fasteners	( )	( )	( )
Light construction; plans, elevations and details	( )	( )	( )
Structural Steel details	( )	( )	( )
Reinforced concrete details	( )	( )	( )
Prestressed concrete details	( )	( )	( )
Manhole and sewer details	( )	( )	( )
Highway structures	( )	( )	( )
Geographical maps (small scale)	( )	( )	( )
Topographic maps (large scale)	( )	( )	( )
Stadia drawings	( )	( )	( )
Contours	( )	( )	( )
Certified survey maps	( )	( )	( )
Sub-division plats	( )	( )	( )
Cross sections	( )	( )	( )
Profiles	( )	( )	( )
Right-of-way plats	( )	( )	( )
Highway Topography	( )	( )	( )
Highway Geometric design	( )	( )	( )
Highway Plans	( )	( )	( )
Highway details	( )	( )	( )
Rural intersections	( )	( )	( )
Urban intersections	( )	( )	( )
Highway drainage	( )	( )	( )
Highway lighting	( )	( )	( )
Traffic control devices	( )	( )	( )
Comments:			

Material Testing			
Aggregate testing	( )	( )	( )
Portland Cement Concrete testing	( )	( )	( )
Asphalt concrete testing	( )	( )	( )
Comments:			

	Knowledge is Essential	Some Knowledge Necessary	No Knowledge Necessary
Soils			
Composition and structure of soil	( )	( )	( )
Compaction testing	( )	( )	( )
Soil classification	( )	( )	( )
Soil testing and analyses	( )	( )	( )
Comments:			
Material Testing			
Classification and Identification of Common rocks	( )	( )	( )
Physical properties - strength, durability, porosity, workability, specific gravity	( )	( )	( )
Production of crushed rock and stone	( )	( )	( )
Methods of sampling and testing	( )	( )	( )
Gradation and design	( )	( )	( )
Handling and storing aggregates	( )	( )	( )
Portland Cement Concrete			
Elements of quality concrete - workability strengths, permability and durability	( )	( )	( )
Concrete mixtures design and admixtures	( )	( )	( )
Manufacture and transportation of concrete	( )	( )	( )
Placement and handling	( )	( )	( )
Plant and field testing and inspection	( )	( )	( )
Asphalt Concrete			
Aggregate sampling and testing	( )	( )	( )
Mix design principles	( )	( )	( )
Manufacture and transportation	( )	( )	( )
Placement methods and equipment	( )	( )	( )
Plant and field testing and inspection	( )	( )	( )
Soil Mechanics			
Composition and structure of soil			
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Granular structure	( )	( )	( )

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Grain size analyses	( )	( )	( )
Specific Gravity	( )	( )	( )
Atterberg Limits	( )	( )	( )
Soil Identification	( )	( )	( )
Moisture - Density			
Water balloon	( )	( )	( )
Sand cone	( )	( )	( )
Nuclear	( )	( )	( )
California Bearing Ratio	( )	( )	( )
Consolidation	( )	( )	( )
Soil Sampling			
Auger	( )	( )	( )
Shelby Tube	( )	( )	( )
Split Spoon	( )	( )	( )
Unconfined Compressive Strength	( )	( )	( )
Percolation	( )	( )	( )
Seismograph Exploration	( )	( )	( )
Resistivity Exploration	( )	( )	( )

APPENDIX C

LIST OF

STUDENT RESPONDENT EMPLOYERS

STUDENT RESPONDENT EMPLOYERS

City of Fort Atkinson
National Survey Service
Clark Dietz and Associates
Wisconsin Department of Transportation, Division of Highways, 16
Centralia Concrete
Dey's Inc.
Coors Porcelain
Hercules Construction & Engineers, Inc.
Len Schlobohm Construction
Soil Testing Services (5)
Town of Weston - Engineering Department
Foth & Van Dyke (3)
UW-Platteville (2) (Further school)
Boulanger Construction
Green Bay Water Utility
Chen & Associates
Beloit Corporation
Owen Ayres & Associates
City of Wauwautosa
Spancrete Industries, Inc.
City of Wisconsin Rapids
Wood County (Norwood Hospital)
Kieclrowski Engineering
Perry-Carrington Engineering Corporation
Marshfield Clinic
D'Onofrio, Kottke, & Associates
Florence County Highway Commission
Kimberland Ltd.
Baudhuin & Associates
Shuster Construction, City of De Pere
Chicago & Northwestern Railroad
Zeff, Cogorno & Sealy, Inc. (3)
Donohue & Associates
Mid-State Associates
U.S. Air Force

APPENDIX D

L I S T O F

E M P L O Y E R R E S P O N D E N T S

EMPLOYER RESPONDENTS

David J. Roach
Thousand, Anthony Surveyor
Portage County Highway Department
City Engineer, City of Wausau
V & M, Inc.
City Engineer, City of Milwaukee
Spancrete Industries, Inc.
Karl Voelkel
Green Bay Water Utility
Department of Transportation, Milwaukee
District #4, Wisconsin Rapids Department of Transportation
National Survey Service
D'Onofrio & Kottke & Associates
City Engineer, Stevens Point
C. Allen Wortley
Tony Kieprowski, P.E.
District 1, Highway Commission, Madison
City of Madison, Assistant City Engineer
Wisconsin Gas, Milwaukee
City of Wisconsin Rapids, Assistant Surveyor